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ENVIRONMENTAL CHARACTERISTICS OF BIODIVERSITY OF BINAGADI KIR LAKE

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Abstract. The territory of Baku is surrounded by a lake-marsh system. The development of numerous lakes in the Absheron is due to a complex of climatic and geological-lithological factors. One of the largest lakes is Binagadi Lake, with a total area of 0.015 km^2. In order to determine the current ecological state of the dynamics of ecological groups of birds, as well as the vegetation and soil cover of Binagadi Lake, we conducted field studies in the autumn-winter period of 2021-2022. Based on the results of the authors' own research and literature data, the paper provides data on 37 bird species belonging to 11 orders, both migrants and sedentary, and also discusses fossil burials of the Pleistocene period in the Binagadi lake. The taxonomy, abundance and residence status of these species have been determined, some of which are included in the Red Book of Azerbaijan: *Aguilla nipalensis*: LC: IV.1; *Buteo rufinus*: LC; IV.1; *Falco naumanni:* LC; III; *Porphyrio porphyrio*: LC; II.5; *Ardea purpurea*: LC; II.5. When studying the vegetation cover of the lke and adjacent areas, 27 species of vascular plants were found belonging to 10 families and 22 genera, of which 22 species are annuals, and 5 species are perennials. When carrying out soil-field studies, it was established that gray-brown saline-solonetzic soils are widespread in this territory and gray-brown primitive soils are locally found. These soils are low fertile (humus - 0.82-1.11%), highly carbonate (33%), clay and heavy clay (53-70%) and deeply saline (3.7%).

Keywords: *Binagadi Lake, Pleistocene fauna, bird migrations, vascular plants, gray-brown primitive soils.*

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1. Introduction

The Absheron Peninsula is famous for its relic lakes - there are about 40 of them on the peninsula. The lakes are salty, fresh, kir. First of all, it should be noted that the Absheron land has long been known for its large reserves of oil and gas. Studies have shown that liquid hydrocarbons from shale deposits, under pressure from a depth of 900-1500 m, rose to the surface, forming oil and bitumen lakes (www.naturalhistorymag.com/author/said-huseynov). Binagadi bituminous lake, which is the object of our research, is also such.

Bituminous lakes, which are often called "tar pits", are a very rare phenomenon in nature. To date, only six large lakes are known, of which only three are sufficiently known. These are the lakes:

1. Peach Lake (La Brea, Trinidad and Tobago);
2. Rancho La Brea (Los Angeles, California, USA);
3. Binagadi (Binagadi, Baku, Azerbaijan).

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Trinidad is of interest as the largest natural bituminous lake, its area is 40 hectares, Los Angeles and Binagadi, famous for a huge number of finds of fossil animals (https://pulse.mail.ru/article/binagadinskij-nosorog-i-drugie-chudesa-kirovogo-ozera-v-baku-4380216029150453936-1071691053479819081/).

At the same time, if the age of the lakes at the La Brea ranch is 35-60 thousand years, then the Binagadi kir lake was formed about 190 thousand years ago. It is formed from kir: a mixture of thick oil, asphalt and clay-sand rocks. Binagadi kir lake is located 7 km northwest of Baku and 0.5 km southeast of the village of Binagadi (fig.) (Aliyev & Mamedov, 2016). It is famous for the large burial of samples of fauna and flora of the Quaternary period.

The lake was formed about 190 thousand years ago. Then it was freshwater and covered an area of 650 thousand square kilometers (whc.unesco.org/en/tentativelists/1175/ "Binegadi" 4th Period Fauna and Flora Deposit). Gradually the lake solidified. This natural Pleistocene reservoir, filled with bitumen, the reflections of which resembled the surface of the water, attracted waterfowl. They landed on the surface of the lake and found themselves in a "trap". Other animals also came to the watering hole and also got stuck in bitumen. Thus, Binagadi Lake became the site of a large burial site for samples of fauna and flora of the Quaternary period (Mustafayev, 2016, 2022).

In this "cemetery" 50 thousand animal bones were found, as well as skeletons of such species as the Pleistocene wolf, cave hyena, primitive bull, subspecies of red deer, bear, and from birds - geese, hawks, golden eagles, swans, owls, pelicans, ducks, ravens. Most of all, skeletons of various bird species were found - 110, some of which still exist (Boev, 2010). Also found: 1 species of mollusc, 107 species of insects, 1 species of amphibian, 2 species of reptiles and the remains of 22 species of plants (www.gia.az/view.php?lang=ru&menu=78&id=1084 Quaternary fauna of Binagadi).

For example, in the Binagadi kir lake, archaeological excavations discovered the skeletons of the following animals: giant cave hyenas, Balakhani wolves, Binagadi rhinos with one and a half meter horns, large porcupines, red deer, primitive bulls. All these animals came to the lake to drink and, bogged down in bitumen, died.

As a results of plant remains, it was found that during the Pleistocene period, the climate of the Absheron Peninsula was colder and wetter.

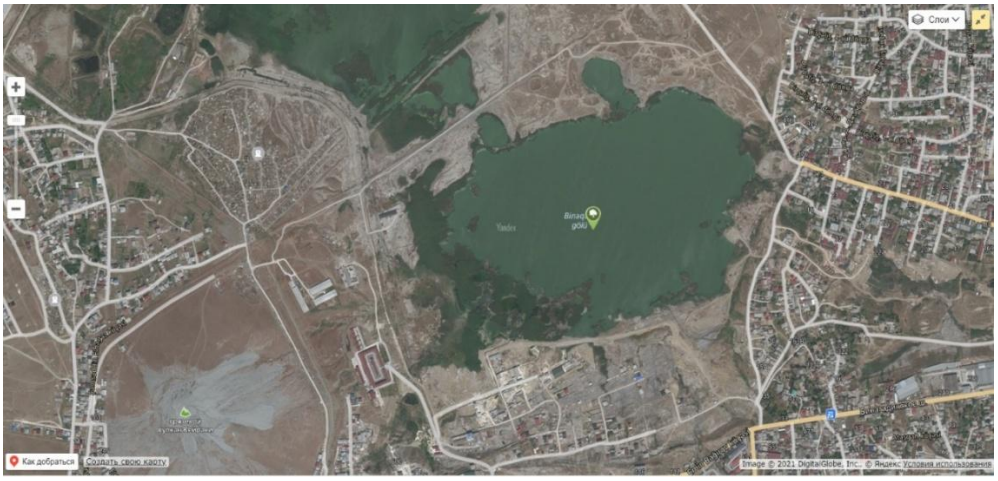

Fig 1. Binagadi Lake (https://tochka-na-karte.ru/Attractions/484-Binagadinskoe-mestonahozhdenie-chetvertichnoj-flory-i-fauny.html)

From a scientific point of view, the Binagadi burials help to recreate the flora and fauna of the Pleistocene period of the Transcaucasus region and, in part, Ciscaucasia and Central Asia (Eibatov *et al*., 2015).

The finds discovered in the Binagadi burial of flora and fauna are exhibited at the Museum of Natural History named after H. Zardabi of the Institute of Geology of the National Academy of Sciences of Azerbaijan. Back in 1982, the Council of Ministers of Azerbaijan declared Lake Binagadi - a monument of the Pleistocene period - the State Natural Monument. On September 30, 1998, the burials of Binagadi Lake were included in the UNESCO World Heritage List.

2. Methods and materials

The object of research is the Binagadi kir lake with an area of 0.015 km^2.

In order to determine the current ecological state of the vegetation and soil cover near Binagadi Lake, the dynamics of ecological groups of birds, we conducted field studies in the autumn-winter period of 2021-2022. All types of birds, both resident and migratory, were taken into account on Binagadi Lake, and their species composition was determined.

The article used analyzes of literature data and the results of our research. Bird observations were made with binoculars and telescopes. To identify bird species, the book identification of birds "The most complete guide to the birds of Britain and Europe" was used, and the number was counted according to generally accepted methods in ornithology with minor changes (Svensson, 2010).

The identification of plants was carried out according to the sources "Flora of Azerbaijan" (Flora of Azerbaijan, 1951-1961), "Flora of Absheron" (Karyagin, 1952), the grouping of species by families and genera is given according to the APG IV system (The Angiosperm Phylogeny Group, 2016). The phenological phases of plants are designated according to the method of V.V. Alekhin (Alekhin, 1938).

Physical and chemical analyzes of the taken soil samples were carried out according to the following method: humus and total nitrogen - according to I.V. Tyurin, particle size distribution - according to N.A.Kachinsky, pH-water suspension - pH meter, CO_2 carbonates - calcimeter, gross phosphorus - according to A.M. Meshcheryakov, full water extract according to D.I. Ivanov (Arinushkina, 1970).

3. Results and discussion

Fauna. The oceans and seas are known to play an important role in the migration routes of many bird species. In this regard, Azerbaijan, with its lacustrine, wetlands, is of particular importance for the passage of birds. One of the most powerful bird flyways in Eurasia passes through Azerbaijan from Eastern Europe and Western Siberia to the south to East Africa and Southwest Asia and back. Every year, at least several million birds fly through Azerbaijan, especially wetland birds. Of particular interest to birdwatchers is Mount Beshbarmag, where up to 200 000 birds fly by every day in autumn and spring. In terms of the number of arriving waterfowl, Azerbaijan ranks third in the Western Paleoarctic, second only to Great Britain and Iran.

Many species of migratory waterfowl stop at the Absheron lakes for nesting, wintering, or for both life cycles.

The Binagadi kir lake is still “in demand” today - different types of birds come here for wintering. During field work on the lake, 37 species of birds were recorded, of which the majority are migrants. The taxonomy, abundance and residence status of species are presented in tables 1 and 2.

Table 1. Species of birds recorded on Binagadi Lake

Order	Family	Species	Quantity	Residence status
Padicipediformes		*Tachibaptus ruficollis*	6	Wintering
		Podiceps cristatus	14	Sedentary
Ciconiiformes	*Ardeidae*	*Ardea purpurea*	2	On the span -nesting
Ansiriformes	*Anatidae*	*Splatula querquedula*	6	On the span
		Anas platyrhynchos	4	Winters and nests
		Netta rufina	2	Winters and nests
Falconiformes	*Accipitridae*	*Aquila nipalensis*	2	On the span
		Clanga pomarina	1	On the span -nesting
		Buteo rufinas	2	Winters regularly, nests sporadically
		Circus aeruginosus	4	Sedentary
		Falco naumanni	2	Nesting
Cruiformes	*Rallidae*	*Porphyrio porphyrio*	6	Sedentary
		Gallinula chloropus	12	Sedentary
		Fulica atra	20	Sedentary
Charadriiformes	*Recurvirostridae*	*Himantopus himant opus*	6	On the span
	Scolopacidae	*Tringa giareola*	3	Nesting
		Actitis hypoleucos	4	Nesting
		Calidris pugnas	12	Wintering, occasional nesting
	Lariidae	*Larus cachinnannas*	4	Nesting
		Chroicocephalus ridibundis	15	Winters and nests
Columbiformes	*Columbidae*	*Columba livia*	8	Sedentary
		Streptopelia senegalensis	2	Sedentary
Cuculiformes		*Cuculus canorus*	2	Sedentary
Apodiformes		*Apus apus*	X	Nesting
Coraciformes	*Upupidae*	*Upupa epops*	1	Nesting
Passeruformes	*Hirundinidae*	*Riparia riparia*	X	Nesting
		Hirundo rustica	X	Nesting
	Alaudidae	*Galerida crustata*	2	Sedentary
	Motacillidae	*Motacilla alba*	2	On the span, rarely wintering
		Motacilla flava	4	Nesting
	Sturnidae	*Sturnus vilgaris*		Sedentary
	Corvidae	*Pica pica*	1	Sedentary
		Corvus cornix	4	Sedentary
		Acrocephalis arundinaceus	4	Nesting
	Turdidae	*Oenanthe oenanthe*	2	Nesting
		Oenanthe isabellina	2	Nesting
		Passer domesticus	60	Sedentary
Total		37	223	

Table 1 presents data on 37 bird species belonging to 11 orders. The total number of individuals is 223.

Orders are represented by the following species and the number of individuals: *Padicipediformes* – 2 species (20 individuals), *Ciconiiformes* – 1 species (12 individuals), *Anseriformes* – 3 (12), *Falconiformes* – 5 (11), *Cruiformes* – 3 (38), *Charadriiformes* – 6 (44), *Columbiformes* – 2 (10), *Cuculiformes* – 1 (2), *Apodiformes* – 1 (a lot of), *Passeruformes* – 12 (swallows, starlings, passerines are numerous), the remaining 8 species are represented by 21 individuals.

Among the noted species there are species included in the Red Book of Azerbaijan: *Aguilla nipalensis*: LC: IV.1; *Buteo rufinus*: LC; IV.1; *Falco naumanni*: LC; III; *Porphyrio porphyrio:* LC; II.5; *Ardea purpurea*: LC; II.5.

According to our observations, supported by literature data, most migrants arrive at the lake in early spring. Table 2 shows the seasonal occurrence of species on the Binagadi Lake.

Table 2. Seasons for the stay of birds on Binagadi Lake

No	Species	Spring arrival	Autumn departure
1	*Ardea purpurea*	March-April	September-October
2	*Aquila nipalensis*	-«-	-«-
3	*Clanga pomarina*	-«-	October
4	*Falco naumanni*	-«-	-«-
5	*Himantropus himantropus*	-«-	August-September
6	*Tringa giareola*	-«-	-«-
7	*Actitis hypoleucos*	-«-	-«-
8	*Calidris pugnas*	-«-	-«-
9	*Chroicocephalus ridibundis*	-«-	-«-
10	*Apus apus*	April	August
11	*Upupa epops*	March-April	August-September
12	*Riparia riparia*	-«-	September
13	*Hirundo rustica*	-«-	-«-
14	*Motacilla flava*	-«-	-«-
15	*Motacilla alba*	-«-	-«-
16	*Anas platyrhynchos*	August-September	November
17	*Netta rufina*	February-March	October-November
18	*Larus cachinnannas*	End of January	-«-
19	*Apus apus*	April	August

The migration season for most species lasts from the beginning to the end of March and April, departure falls on September-October. Our observations just fell on the beginning of migration and, apparently, therefore, the number of individuals was low. It should be noted that any pond on the flight paths of birds should be in the epicenter of attention of organizations involved in conservation measures for biodiversity.

Vegetation cover. The vegetation of the surroundings of Lake Binagadi is represented by semi-desert communities typical of Absheron. The species registered by us in the study area are typical plants for Absheron. During the field studies near Lake Binagadi and adjacent areas, 27 species of vascular plants belonging to 10 families and 22 genera were registered, 22 of tem are annuals, 5 are perennials. In the spring season,

rapid development of ephemerals were observed in the study area. Table 3 provides information on the floristic composition and vegetation phases of semi-desert phytocenoses.

Table 3. Floristic composition and phases of vegetation of phytocenoses of Binagadi Lake

No	Latin names	Phenophase (16.04.2022)
1.	*Plantago coronopus* L.	F_3
2.	*P. loeflingii* L.	F_2
3.	*Parapolis incurva* (L.) C.B.Hibb.	F_3
4.	*Poa annua* L.	F_3
5.	*Lolium rigidum* Gaudin.	Veg.
6.	*Hordeum leporinum* Link.	F_2
7.	*Bromus scoparius* L.	F_2
8.	*Calendula persica* C.A.Mey	F_1-F_2
9.	*Salsola dendroides* Pallas	Veg.
10.	*Climacoptera crassa* (M.Bieb.) Botsch.	Veg.
11.	*Artemisia fragrans* Willd.	Veg.
12.	*Senecio vernalis* Waldst. et Kit.	F_2
13.	*S.vulgaris* L.	F_2
14.	*Carduus arabicus* Jacquin ex Myrray	F_2
15.	*Crepis sancta* (L.) Babc.	F_2
16.	*Medicago minima* (L.) Bartalini	F_1- F_2
17.	*M.orbicularis* L.	F_2
18.	*Capsella bursa-pastoris* (L.) Medikus	F_2
19.	*Maresia nana* (DC) Batt	F_2
20.	*Lepidium draba* L.	Veg.
21.	*Erodium ciconium* (L.) L'Hérit.	F_2
22.	*E. cicutarium* (L.) L'Hérit.	F_2
23.	*Spergularia salina* J.Presl et C.Presl	F_1

Common reed *Phragmites australis* (Cav.) Trin. was observed in the center of the lake on small islands and along the shore. ex Steudel. In addition, the species *Lemna* sp., *Ranunculus sceleratus* L., *Spergularia rubra* (L.) J. Presl et C. Presl are distributed along the lake shore.

In the course of reviewing the literature of recent years on the study of the flora of Absheron, there is a mention of the probability of the spread of the species *Spergularia rubra* (L.) J. Presl et C. Presl in the territory of Absheron (with reference to G.F. Akhundov, in the multi-volume Flora of Azerbaijan, vol. III, 312.), but the exact location of the species is not indicated. Taking into account the above, we believe that the exact location of *Spergularia rubra* (L.) J.Presl et C.Presl was first recorded by us in the adjacent areas of Lake Binagadi.

The soil cover of the Absheron Peninsula has been studied by many researchers (Sultan-zade, 1997; Galandarov et al., 2000; Talybov, 2004; Mamedov et al., 2005). The following varieties of gray-brown soils are common in the study area: gray-brown solonetzic; gray-brown solonetzic irrigated; gray-brown saline-solonetzic; gray-brown underdeveloped; gray-brown primitive and gray-brown swampy soils. Gray-brown saline-solonetzic soils occupy the western part of the Absheron Peninsula and are used for winter pastures.

According to the results of our studies carried out in the soils of the adjacent territories of the Binagadi region, it was found that the main soils common in this

territory are gray-brown saline-alkaline and in some places primitive soils. According to the results of laboratory analyzes of the taken soil samples, these soils are mainly heavy loamy and clayey (<0,01 mm -39-70%); along with an increase in the total content of physical clay, the amount of silt particles also noticeably increases (<0,001 mm-10-25%), which is in good agreement with morphological features (Table 4). The results of the analyzes indicate low values of humus in the upper part of the profile (0,82-1,04%) and its sharp decrease after a half-meter layer (0,26-0,40%).

Table 4. Physical and chemical parameters of gray-brown soils of nearby areas of Binagadi Lake

Parameters	Gray-brown saline-alkaline	Gray-brown primitive
Granulometric composition,%		
<0,01 mm	53,32-70,40	21,56-39,04
<0,001 mm	19,52-25,71	10,49-13,24
Humus, %		
0-20 cm	0,82-1,11	0,63-1,04
0-50 cm	0,64-0,95	0,48-0,80
0-100 cm	0,26-0,40	---
Nitrogen, %		
0-20 cm	0,10-0,13	0,07-0,13
0-50 cm	0,07-0,10	0,04-0,11
Phosphorus,%		
0-20 cm	0,14-0,18	0,11-0,14
0-50 cm	0,12-0,15	0,10-0,12
Sum of absorbed bases, 100 g per soil		
0-20 cm	21,90-27,43	12,04-19,41
0-50 cm	21,75-25,11	12,0-18,98
pH	8,5-9,0	8,0-8,4
$CaCO_3$, %	12,18-26,04	13,04-33,91
Dense residue, %	0,22-3,70	0,1-0,27

The decrease in the values of total nitrogen along the profile corresponds to the values of humus, amounting to 0,07-0,13% in the arable layer, decreasing to the underlying horizons to 0.04%. The content of carbonates in gray-brown saline-alkaline and primitive soils varies within a fairly wide range (12-33,0%), and mainly depends on the plasticity of the surface and the nature of soilforming rocks. The process of carbonate leaching, in most of the sections judging by the abundant white eyes and the strong accumulation of $CaCO_3$ along the profile at a depth of 40-80 cm, is well expressed.

The results of the analysis of exchangeable bases show a relatively average value of the absorption capacity of the studied soils, which varies in the upper horizons from 12-27 meq per 100 g. soil. In the composition of absorbed bases, a significant proportion falls on Ca^{2+}, the value of which reaches up to 68%, the values of exchangeable Mg^{2+} are also high, and amount to 21-35% of the total absorbed bases. In the soil profile, a rather high content of absorbed Na^{+} is noted: Sodium reaches its maximum values in the middle of the profile - 9-17%. The relatively high content of absorbed Na+, along with morphological features, confirms the high alkalinity of soils near Lake Binagadi.

The high alkalinity of these soils is also confirmed by a clear alkaline reaction (pH – 8,0-9,0). The data of the water extract analysis show that these soils differ in a very different degree of salinity; easily soluble salts in significant quantities (0,15-3,7%) are noted deeper than 0,5-0,8 m with a clear predominance of sulfates in the composition of salts.

4. Conclusions

1. According to the results of research on the lake, 37 species of birds belonging to 11 orders were recorded, with a total number of 223 individuals. The taxonomy, abundance and status of these species were determined. It has been established that some of these species are included in the Red Book of Azerbaijan: *Aguilla nipalensis*; LC: IV.1; *Buteo rufinus*: LC; IV.1; *Falco naumanni*: LC; III; *Porphyrio porphyrio*: LC; II.5; *Ardea purpurea*: LC; II.5.
2. During the field research on the study of the flora of Lake Binagadi were established distribution of 27 species of vascular plants belonging to 10 families and 22 genera, of which 22 species are annuals, 5 species are perennial.
3. Based on the results of soil-field researches, it was established that the main soils common in this area are gray-brown saline-alkaline and in some places primitive soils. These soils are characterized by low fertility (humus content 0,82-1,11%), high carbonate content (33%), alkalinity (pH-8,0-9,0), clay content (53-70%) and salinity (3,7%).

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